Union of Concerned Scientists

Citizens and Scientists for Environmental Solutions

Statement Submitted by David Lochbaum to the House Government Reform Subcommittee on Energy and Resources: "The Next Generation of Nuclear Power"

Mr. Chairman and members of the Subcommittee, I would like to thank you on behalf of the Union of Concerned Scientists for the opportunity to present our views on the next generation of nuclear power.

My name is David Lochbaum. I have been the Nuclear Safety Engineer for the Union of Concerned Scientists (UCS) since October 1996. Prior to joining UCS, I worked in the nuclear power industry for more than seventeen years. I received a Bachelor of Science degree in Nuclear Engineering from the University of Tennessee in June 1979.

UCS, established in 1969, is a nonprofit partnership of scientists and citizens combining rigorous scientific analysis, innovative policy development, and effective citizen advocacy to achieve practical environmental solutions. UCS has monitored nuclear safety for over 30 years. We are neither a proponent nor an opponent of nuclear power. We advocate nuclear safety.

The subject of today's hearing is not new to me. Fifteen (15) years ago when I still worked in the industry, I served on the Committee for New Construction, a panel created by the American Nuclear Society (ANS) to examine the issues before this Subcommittee today. I volunteered to serve on that panel because I felt the proper foundation for the next generation of reactors was lacking and I wanted to make sure the steps needed to provide that foundation were taken. The circumstances motivating me to action back then included the year-plus outages needed to restore safety levels at the Peach Bottom (PA), Pilgrim (MA), Davis-Besse (OH), Surry (VA), Calvert Cliffs (MD), Nine Mile Point (NY), Sequoyah (TN) and Browns Ferry (AL) nuclear plants in the mid to late 1980s and the nuclear industry's inability to stop the poor performance pattern. I find myself in the same role today. It is my hope that my participation in this Congressional hearing will be more successful in establishing the right foundation for the next generation of nuclear power than my involvement in that ANS panel.

GENERATION GAPS

It is more sad than ironic that we hear today about a Generation IV array of nuclear reactors when we do not have a Generation I high-level waste disposal site or a Generation III regulator. These generation gaps are *prima facie* evidence that we lack a proper foundation for the next generation of nuclear power reactors. This Subcommittee and the Congress must take steps to narrow rather than widen these gaps.

GENERATION GAP – NUCLEAR WASTE

More than one hundred nuclear power reactors have operated in the United States despite having no place to store the long-lasting, high-level waste they produce. As the National Academy of Sciences recently described in study conducted for the Congress,[1] the "interim" storage of this hazardous material at nuclear power plant sites across the country caused higher risks and increased costs.

> **Recommendation: The federal government must license a repository for high-level nuclear waste before it licenses the next nuclear power reactor.** [2]

[1] National Academy of Science, "Safety and Security of Commercial Spent Nuclear Fuel Storage," Washingon, DC, 2005.

[2] While UCS advocates the necessity for a geological repository, we have not examined the viability of the proposed Yucca Mountain site in meeting that need. Our point is that the federal government must license and open a suitable repository (i.e., the first generation of high-level waste disposal) prior to licensing another generation of nuclear power reactors.

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GENERATION GAP – NUCLEAR REGULATOR

The other generation gap that the federal government must narrow involves the regulator for nuclear power plants. The Atomic Energy Commission (AEC) was created in 1947 by the Atomic Energy Act. The AEC was charged with the dual tasks of developing nuclear power and regulating its safety. In 1974, the Congress passed the Energy Reorganization Act to separate these conflicting roles by dividing the AEC into the Nuclear Regulatory Commission (NRC) and what is today the Department of Energy (DOE). The NRC is thus a second generation regulatory body. As I testified last year to the Senate,[3] the 2002 near-miss at the Davis-Besse nuclear plant in Ohio, which according to the NRC's own estimates came within a few months of disaster, is merely the latest evidence of the need for NRC reform. My Senate testimony documented the NRC's failure to address repetitive findings by the Government Accountability Office (GAO), the NRC's Office of the Inspector General (OIG), and its own staff. For example, the NRC's internal examination of its Davis-Besse regulatory breakdown tabulated lessons learned from the regulatory breakdowns at Indian Point (2000), Millstone (1997), and South Texas Project (1995) that remained unimplemented and contributed to yet another breakdown.[4] More than two years after determining that failure to implement past lessons learned contributed to the Davis-Besse regulatory breakdown, the NRC has still not implemented nearly 25 percent of the lessons learned the agency itself deemed "high priority."[5] In all too many respects, the NRC today is what NASA was prior to the *Columbia* disaster. The NRC's failure to resolve known problems mirrors NASA's failures to address o-ring problems prior to the *Challenger* disaster and foam debris problems prior to the *Columbia* disaster. A nuclear plant disaster would likely bring about the reforms needed at NRC – it is our hope that these overdue reforms can be obtained without that high price tag.

The NRC and its predecessor the AEC have licensed a total of 132 nuclear power reactors. Forty-four reactors have had to shut down for outages lasting at least one year in order to restore the minimum safety levels prescribed by federal regulations. The year-plus durations reflect how far safety levels were below acceptable levels and how much higher the costs of nuclear electricity generation were above what they should have been. An effective regulator would neither be blissfully unaware of safety problems so extensive that it takes a year to fix them nor be so passively tolerant as to watch safety problems deepen and broaden until a year is needed to fix them. By letting 44 reactors bury themselves into year-plus safety holes, the NRC has repeatedly demonstrated it is not an effective regulator.

Other compelling evidence of the need for reform at the NRC comes from surveys of its employees by the NRC's OIG. The latest survey reported:[6]

> *Slightly more than half (53%) of the employees feel that it is "safe to speak up in the NRC"*
>
> *In comparison with 1998 survey data, the only item that shows a significant decrease (-5 percentage points) in favorability is "I believe NRC's commitment to public safety is apparent in what we do on a day-to-day basis."*

Forty-seven (47) percent of NRC employees do not feel it is safe to speak up in the NRC! An effective regulator simply does not silence its own staff.

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[3] David Lochbaum, Nuclear Safety Engineer, "Testimony before the Senate Subcommittee on Clean Air, Climate Change and Nuclear Safety," May 20, 2004.

[4] Lessons Learned Task Force, U.S. Nuclear Regulatory Commission, "Degradation of the Davis-Besse Nuclear Power Station Reactor Pressure Vessel Head Lessons-Learned Report," Appendix F, "Summary of Related Issues Involving Previous NRC Lessons-Learned Reports," September 2002.

[5] U.S. Nuclear Regulatory Commission internal memo dated February 22, 2005, from J. E. Dyer, Director – Office of Nuclear Reactor Regulation, to Luis A. Reyes, Executive Director for Operations, "Semiannual Report – Status of Implementation of Davis-Besse Lessons Learned Task Force Report Recommendations."

[6] Office of the Inspector General, U.S. Nuclear Regulatory Commission, OIG-03-A-03, "2002 Survey of the NRC's Safety Culture and Climate," November 2002.

These facts should be troubling whether one loves or hates nuclear power, comes from a red state or blue state, sits on left or right side of the aisle, or has a pro-business or pro-safety outlook. Building a next generation reactor without first providing a next generation regulator is destined to produce lower safety levels and higher operating costs than is necessary.

Recommendation: Congress must provide the attention and resources necessary to reform the NRC into a consistently effective regulatory body with a good safety culture.

NEXT GENERATION REACTORS

Dr. Edwin S. Lyman, Senior Scientist in the Global Security Program at UCS, has examined the various reactor designs under consideration for the next generation of nuclear power in the United States. My testimony summarizes his work and its results. Dr. Lyman observed that, until recently, development largely focused on "evolutionary" refinements of current reactor designs. The NRC certified three of the evolutionary designs: the General Electric Advanced Boiling Water Reactor (ABWR), and the Westinghouse System-80+ and AP-600 Pressurized Water Reactors (PWRs). A scaled-up version of the AP-600, the AP-1000, is under certification review, and five other evolutionary designs are under pre-certification review.

The ABWR and System-80+ designs are very similar to current plants. Although certified by the NRC, they have not led and are unlikely to lead to any new U.S. reactor orders – absent heavy subsidization – because of their high capital costs. The AP-600 was designed to significantly reduce capital costs "*by eliminating equipment which is subject to regulation*."[7] It uses more dual-purpose equipment (e.g., systems that provide feedwater to the steam generators during both normal operation and accidents) and employ "passive safety" features, such as a reliance on gravity, rather than motor-driven pumps.

The AP-600 design has some safety benefits over current reactors, but these gains are largely offset by steps taken to reduce capital costs. Concrete and steel account for a significant portion of the capital costs of current reactors, so Westinghouse reduced the size, and thus robustness, of the containment and other safety-grade structures. Even so, the economics of nuclear plants with mid-range power ratings (e.g. the AP-600) were still too poor to attract customers. As a result, Westinghouse abandoned plans to market the AP-600 in favor of pursuing certification of a bigger version called the AP-1000. The AP-1000 nearly doubles the power output without a proportionate increase in construction cost. However, as a result, the AP-1000 has a ratio of containment volume to thermal power below that of most of current PWRs, increasing the risk of containment overpressure and failure in a severe accident.[8] The other evolutionary designs in pre-licensing review suffer from similar problems.

The pebble-bed modular reactor (PBMR) was another attempt to reduce capital costs through an "inherently safe" design. Proponents of this design, which was submitted by Exelon in 2000 for NRC pre-licensing review, argue that the reactor was so safe that it did not require a pressure-resisting containment, but only a less costly "confinement" building.[9] However, the technical basis for the untested PBMR design was not sufficiently complete to allow the NRC to assess the adequacy of the confinement when Exelon withdrew its application in 2002 and the PBMR pre-licensing proceeding was terminated.

There has been a renewed push in recent years from the DOE for research and development on advanced reactor systems under a program known as "Generation IV" or "Gen IV." The Gen IV program pursues development of five reactor systems. Two are "thermal" reactors – the Very High Temperature Reactor

[7] Westinghouse Electric Company web site, www.AP-600.westinghouse.com.
[8] For the AP-1000, the ratio is 605 cu. ft/MWth, compared to 885 cu. ft/MWth for the AP-600, which is in the range of most operating PWRs.
[9] The U.S. nuclear industry and its regulator touted robust containment designs as the primary reason that a Chernobyl-styled nuclear disaster could not happen here. Chernobyl was equipped with a less costly "confinement" building.

(VHTR) and the Supercritical-Water-Cooled Reactor (SCWR). Three are plutonium-fueled fast-breeder reactors – the Gas-Cooled Fast Reactor (GFR), the Lead-Cooled Fast Reactor (LFR) and the Sodium-Cooled Fast Reactor (SFR). DOE's stated goals for the program are: "*Generation IV … systems will provide sustainable energy generation … will minimize and manage their nuclear waste … will have a clear life-cycle cost advantage … will excel in safety and reliability … will increase the assurance that they are … the least desirable route for diversion or theft of weapons-usable materials*."[10]

Although one Gen IV objective is improved safety, there is little basis to assume that any of the five designs under study would actually be significantly safer than current-generation plants. All the designs use highly corrosive coolants under extreme conditions, and are predicated on the successful development of super-resistant structural materials.[11] This problem is compounded by the fact that some Gen IV designs are intended to utilize long-lived reactor cores in sealed "batteries," with operating cycles lasting from ten to thirty years. The lack of routine maintenance possible in such schemes, coupled with the uncertainties associated with exposure of new materials to extreme thermo-chemical regimes, creates the potential for severe problems.

> **Recommendation: Experiments with new and untested materials must be conducted in laboratory and prototype settings and not in commercial reactors operating near population centers.**

The safety problems with sodium-cooled fast-breeder reactors compared to light-water reactors are well known: a highly reactive coolant that burns if exposed to water or air; prompt positive feedback from coolant boiling that can lead to a far more energetic core disassembly; and a much greater inventory of plutonium and other highly radiotoxic actinides. Lead-bismuth coolant is less reactive and has a higher boiling point, but it is extremely corrosive and produces highly volatile radioisotopes when irradiated.

Most of the proposed Gen IV reactor systems rely on fuel reprocessing: the chemical separation of plutonium from spent fuel for recycling and reuse as fresh fuel. Reprocessing requires the processing, transport and storage of huge quantities of weapon-usable plutonium, and raises serious risks of nuclear proliferation and nuclear terrorism. In spite of this, through the Gen IV International Forum, the United States is enthusiastically trying to stimulate interest in reprocessing in countries ranging from Brazil to South Korea.

The purported benefits of reprocessing have never lived up to the claims of its promoters. Most countries have abandoned breeder reactor development because, compared to current-generation light-water reactors, the costs were considerably higher and the reliability considerably worse. UCS Board Member Dr. Richard Garwin has calculated that there is as much as a 2,000-year supply of uranium fuel for nuclear reactors that could be harvested from seawater less expensively than it can be recycled through breeder reactors.[12] There is little reason to expect that the Gen IV effort will achieve its goals.

> **Recommendation: Congress must ensure that next generation reactor designs satisfy, and not merely pursue, DOE's stated goals.**

Nuclear power's proponents have been many assuring claims about the safety of the next generation reactors. For example, some have argued that the next generation reactors are so safe that emergency sirens and other public protection measures can be eliminated. The shallowness of these claims is evident

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[10] US Nuclear Energy Research Advisory Committee (NERAC), *A Technology Roadmap for Generation IV Nuclear Energy Systems: Executive Summary*, March 2003, p.6.

[11] Material "surprises" have significantly increased nuclear power's costs and lowered its safety performance. For example, equipment degradation led to the premature closure – at high cost – of the Fort St. Vrain and Trojan nuclear plants.

[12] Richard L. Garwin, "Can the World Do Without Nuclear Power? Can the World Live With Nuclear Power?" Presenation at the Nuclear Control Institute, Washington, DC, April 9, 2001.

in the fact that the nuclear industry seeks extension of federal liability protection under the Price-Anderson Act, as amended, for new reactors. If the next generation of reactors were truly safe and reliable, their owners could acquire private liability insurance. That Price-Anderson is so aggressively sought for new reactors demonstrates beyond any reasonable doubt that the safety claims are more marketing panache than reality.

> **Recommendation: If the potential consequences of an accident at a next generation reactor are so catastrophic that federal liability protection under Price-Anderson is necessary for plant owners, then emergency sirens and other emergency preparedness measures are necessary for the people living near those plants.**

PREREQUISITES FOR THE NEXT GENERATION OF NUCLEAR POWER

If there is to be a next generation of nuclear power in the United States, the lessons learned from the existing and past generations of nuclear power must be addressed. Otherwise, safety levels will be lower and costs will be higher than is necessary. The top five lessons yet to be addressed for the next generation of nuclear power are:

- The federal government must license a repository for high-level nuclear waste before it licenses the next nuclear power reactor.
- Congress must provide the attention and resources necessary to reform the NRC into a consistently effective regulatory body with a good safety culture.
- Experiments with new and untested materials must be conducted in laboratory and prototype settings, not in commercial reactors operating near population centers.
- Congress must ensure that next generation reactor designs satisfy, and not merely pursue, DOE's stated goals.
- If the potential consequences of an accident at a next generation reactor are so catastrophic that federal liability protection under Price-Anderson is necessary for plant owners, then emergency sirens and other emergency preparedness measures are necessary for the people living near those plants.

These steps are prerequisites if the next generation of nuclear power is to have a safe and reliable role in American's energy future.

On behalf of more than sixty thousand members of the Union of Concerned Scientists, I thank the Subcommittee for examining this important subject and considering our perspectives.

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